LROC EDR/CDR
DATA PRODUCT
SOFTWARE INTERFACE SPECIFICATION

Version 1.6
December 3, 2008

Signature Page

Prepared by: Ernest Bowman-Cisneros Date SOC Manager, LROC Arizona State University	
Reviewed by: Mark Robinson Date Principal Investigator, LROC Arizona State University	**Reviewed by:** Scott Brylow Date Instrument Manager, LROC Malin Space Science Systems
Reviewed by: Chris Isbell Date Imaging Node, Planetary Data System U.S. Geological Survey	**Reviewed by:** Stan Scott Date Data Manager, Lunar Reconnaissance Orbiter Goddard Space Flight Facility
Approved by: Ed Grayzeck Date Program Manager, Planetary Data System Goddard Space Flight Facility	

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DOCUMENT CHANGE LOG

Date	Change	Affected Portions
2008/03/17	First draft for PDS review	all
2008/03/28	Incorporated comments/suggestions from Eric Eliason and Stan Scott.	Sections 1.1, 2.2, 2.3.2, 2.3.4, 2.4.2, 3.1
2008/05/20	Incorporated comments/suggestions from SIS review panel	Sections 2.1, 2.3, 2.3.3, 2.3.4, 2.5, 3.2, 3.3, Appendix B
2008/05/26	Incorporated comments/suggestions from Stuart Sides (SIS Review panel)	Minor edits in multiple sections.
2008/12/01	Added keyword for recording temperatures at beginning, middle and end of a WAC image series.	Sections 3.2.3, 3.2.4 and 3.3
2008/12/03	Moved md5_checksum keyword to image object for each label example (CIsbell)	Section 3.2
2008/12/03	Added 'object' to md5_checksum description	Section 3.3

TBD/TBR ITEMS

Section	Description	Person

Acronyms and Abbreviations

ASCII	American Standard Code for Information Interchange
ASU	Arizona State University
CDR	Calibrated Data Record
CD-ROM	Compact Disk - Read-Only Memory
CD-WO	Compact Disk – Write Once
CODMAC	Committee on Data Management, Archiving, and Computing
DN	Digital Number
EDR	Engineering Data Record
I/F	See Appendix A -Glossary
ISIS	Integrated Software for Imagers and Spectrometers
ISO	International Standards Organization
JPL	Jet Propulsion Laboratory
LDWG	LRO Data Working Group
LROC	Lunar Reconnaissance Orbiter Camera
MD5	Message Digest algorithm 5
ME	Mean Earth
MET	Mission Elapsed Time
Mini-RF	Mini-Radio Frequency Technology Demonstration
NAC	Narrow Angle Camera
NSSDC	National Space Science Data Center
PDS	Planetary Data System
PSG	Project Science Group
SDVT	Science Data Validation Team
SIS	Software Interface Specification
SOC	Science Operations Center
TBD	To Be Determined
TBR	To Be Reviewed
UV	Ultra-Violet
VIS	Visible
WAC	Wide Angle Camera

1. Introduction

1.1. Purpose and Scope

This Software Interface Specification (SIS) outlines the generation of Lunar Reconnaissance Orbiter Camera (LROC) NAC and WAC EDR (CODMAC Level 2) and CDR (CODMAC Level 3) data products with a detailed description of the products and a description of how the products are generated, including data sources and destinations. The EDR products contain panchromatic NAC image data, monochromatic WAC image data, and seven band WAC image data, while the CDR products contain calibrated panchromatic NAC image data, calibrated monochromatic WAC image data, and seven band calibrated WAC image data.

This SIS is intended to provide enough information to enable users to read and understand the data products.

1.2. Applicable Documents

The following documents are applicable to the development and execution of this document:

1. Lunar Reconnaissance Orbiter Project Data Management and Archive Plan, 431-PLAN-00182. Check with the LRO Project Configuration Management Office to ensure the document is the most current version prior to use.
2. LROC Data Management and Archive Plan, LROC_SOC_PLAN_0001.
3. LROC EDR Archive Volume SIS, LROC_SOC_SPEC_0002.

This SIS is also consistent with the following Planetary Data System documents:

4. *Planetary Data System Archive Preparation Guide*, August 29, 2006, Version 1.1, JPL D-31224.
5. *Planetary Data System Standards Reference*, March 20, 2006, Version 3.7. JPL D-7669, Part 2.
6. *Planetary Data System Data Dictionary Document*, August 28, 2002, JPL D-7116, Rev. E

1.3. Relationships with Other Interfaces

The LROC EDR and CDR Archive Volume SIS describes how the data products specified by this document will be cataloged and made available through the LROC PDS Data Node.

2. Data Product Characteristics and Environment

2.1. Instrument Overview

The LROC consists of two narrow-angle camera components (NACs), a wide-angle camera component (WAC), and a common Sequence and Compressor System (SCS).

Each NAC (see Figure 2.1) has a 700-mm focal-length Cassegrain (Ritchey-Chretien) telescope that images onto a 5000-pixel CCD line-array providing a cross-track field-of-view (FOV) of 2.86°. The NAC readout noise is better than 100 e^- and the data are sampled at 12 bits. By ground command, these 12-bit pixel values are companded to 8-bit pixels using one of several selectable lookup tables during readout from the CCD. The NAC internal buffer holds 256 MB of uncompressed data, enough for a full-swath image 25-km long or a 2x2 binned image 100-km long. NAC specifications are summarized in Table 2.1.

The WAC electronics are a copy of those flown on cameras on Mars Climate Orbiter, Mars Polar Lander, Mars Odyssey, and Mars Reconnaissance Orbiter. The WAC (see Figure 2.2) has two lenses imaging onto the same 1000 x 1000 pixel, electronically shuttered CCD area-array, one imaging in the visible/near infrared (VIS), and the other in the Ultraviolet (UV). The VIS optics have a cross-track FOV of 90° and the UV optics a 60° FOV. From the nominal 50-km orbit, the WAC will provide a nadir, ground sample distance of 75-m/pixel in the visible, and a swath width of ~75 km. The seven-band color capability of the WAC is provided by a color filter array (see Figure 2.3) mounted directly over the detector, providing different sections of the CCD with different filters. Consequently the instrument has no moving parts; it acquires data in the seven channels in a "pushframe" mode, with scanning of the WAC FOV provided by motion of the spacecraft and target. Continuous color coverage of the lunar surface is possible by repeated imaging such that each of the narrow framelets of each color band overlap. The WAC has a readout noise less than 40 e^- and, as with the NAC, pixel values are digitized to 12-bits and are then commanded to 8-bit values through selectable lookup tables. WAC specifications are summarized in Table 2.2. The two UV bands (315 and 360 nm) undergo 4x4 pixel on-chip analog summing before digitization to achieve better signal-to-noise ratio. Thus, UV pixels are recorded at reduced 400-m/pixel sampling but have improved signal properties. Only the center 704 pixels for the visible are digitized when all seven bands are being acquired. WAC band passes are collected UV then VIS (315, 360, 415, 560, 600, 640, 680), but the order is reversed after LRO performs a 180° yaw maneuver to align the solar panels with the sun.

The two NACs and the WAC interface with the Sequencing and Compressor System (SCS), the third element of the LROC (see Figure 2.4). As the name implies, the SCS commands individual image acquisition by the NACs and WAC from a stored sequence, and losslessly compresses the NAC and WAC data as they are read out and passed to the spacecraft data system. The SCS provides a single command and data interface between the LROC and the LRO spacecraft data system through a spacewire interface.

Each NAC has an estimated mass of 5.4 kg, the WAC is 0.6 kg, and the SCS is 0.6 kg, for a total LROC mass of 12 kg. Each NAC will use 10 W during image acquisition or readout, 6 W at all other times; the WAC will use 4 W (continuous), and the SCS will use 6 W (continuous), for a total LROC power dissipation of 30 W peak, 22 W average.

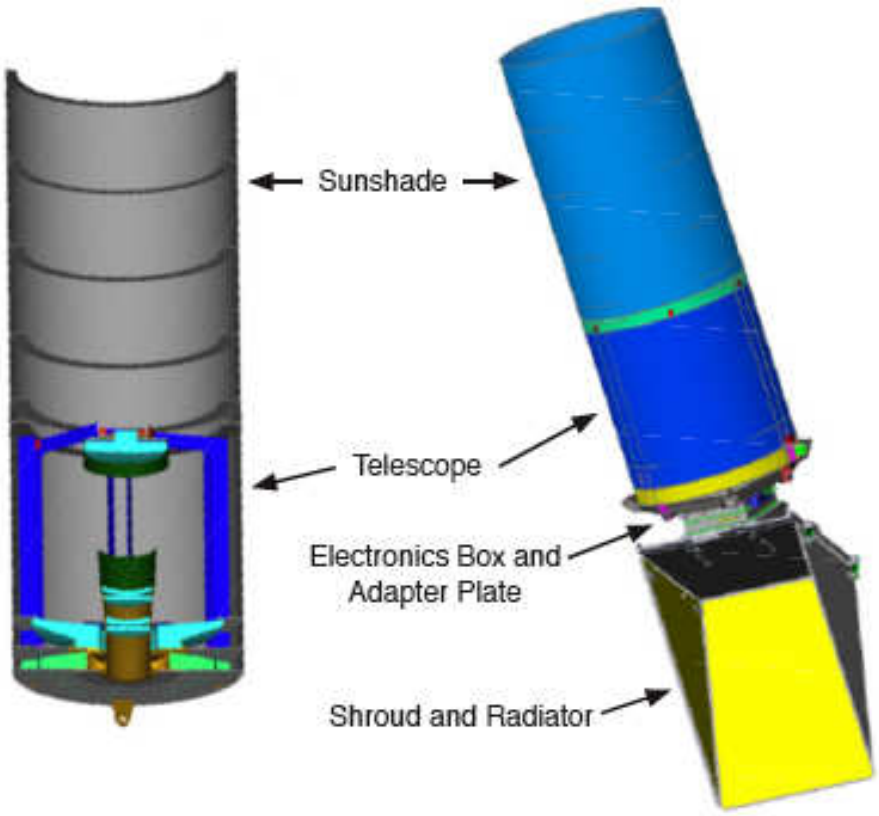

Figure 2.1 - LROC Narrow Angle Camera, 70 cm by 24 cm diameter.

Table 2.1 – NAC Specifications	
Image scale	0.5 meter per pixel (10 micro-radian IFOV)
Maximum Image size	2.5 x 25 km
Optics	f/3.59 Cassegrain (Ritchey-Chretien)
Effective Focal Length	700 mm
Primary Mirror Diameter	195 mm
FOV	2.86°(0.05 radian) per NAC
MTF (Nyquist)	> 0.20
Structure + baffle	Graphite-cyanate composite
Detector	Kodak KLI-5001G
Pixel format	1 x 5,000*
Noise	100 e-
Analog/Digital Converter	Honeywell ADC9225
FPGA	Actel RT54SX32-S
Volume	70 cm x 26 cm diameter
Peak Power	10 W
Average Power	6 W
Spectral Response	400-750 nm

* CCD specification is actually 5056 pixels, with 32 on the right and left representing dark reference pixels. TBD if these pixels will be recorded into image file.

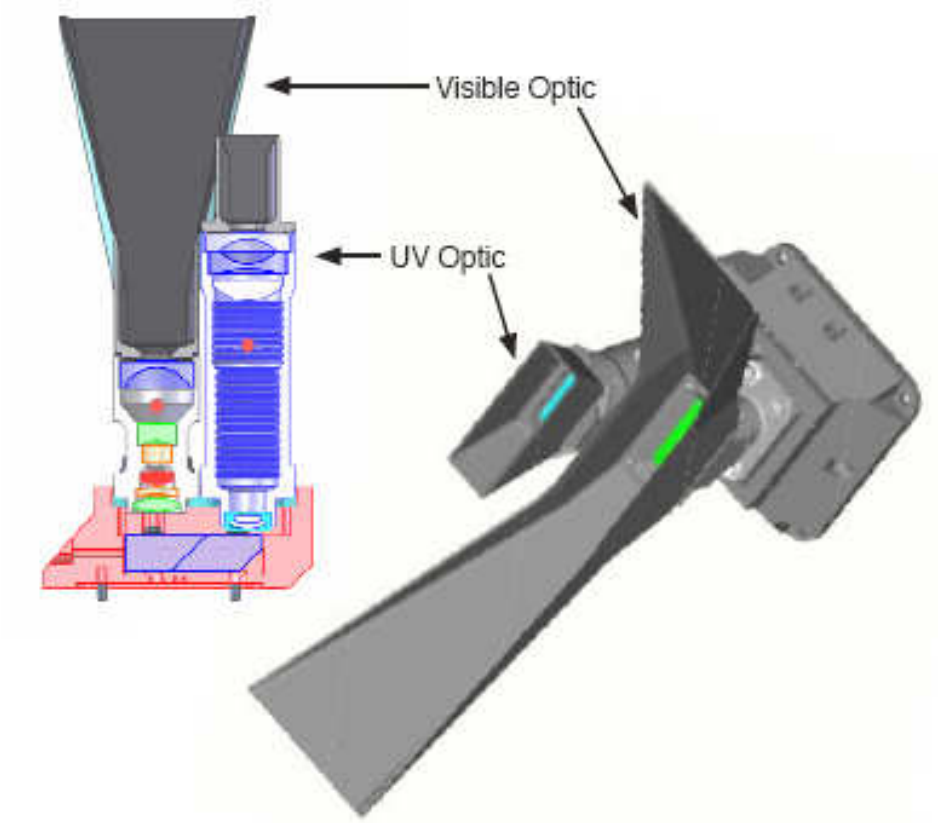

Figure 2.2. - LROC Wide Angle Camera

Table 2.2 – WAC Specifications	
Image format	1024 x 16 pixels monochrome (push frame) 704 x 16 pixels 7-filter color (push frame)
Image scale	1.5 milliradian, 75 meters/pixel nadir (vis) 2.0 milliradian, 400 meters/pixel nadir (UV, 4x binned)
Image frame width (km)	110 km (vis monochrome) 88 km (vis color) 88 km (UV)
Optics	f/5.1 (vis) f/5.3 (UV)
Effective Focal Length	6.0 mm (vis), 4.6 mm (UV)
Entrance Pupil Diameter	1.19 mm (vis), 0.85 mm (UV)
Field of View	90° (vis) 60° (UV)
System MTF (Nyquist)	> 0.2
Electronics	4 circuit boards
Detector	Kodak KLI-1001
Pixel format	1,024 x 1,024 *

Table 2.2 – WAC Specifications	
Noise	50 e-
Volume	14.5 cm x 9.2 cm x 7.6 cm
Peak Power	4 W
Average Power	4 W
Filters	315 nm 360 nm 415 nm 560 nm 600 nm 640 nm 680 nm

** In BW mode, 1024 pixels are read out. In color mode only the center 704 VIS pixels are read out.*

Table 2. WAC specifications.

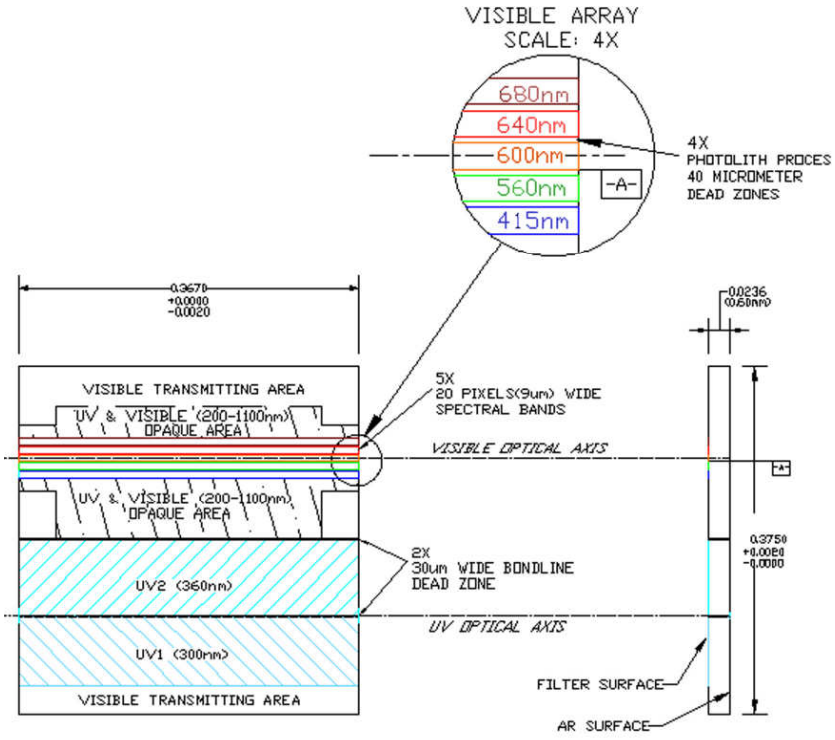

Figure 2.3 - Diagram of LROC Wide Angle Camera filter assembly.

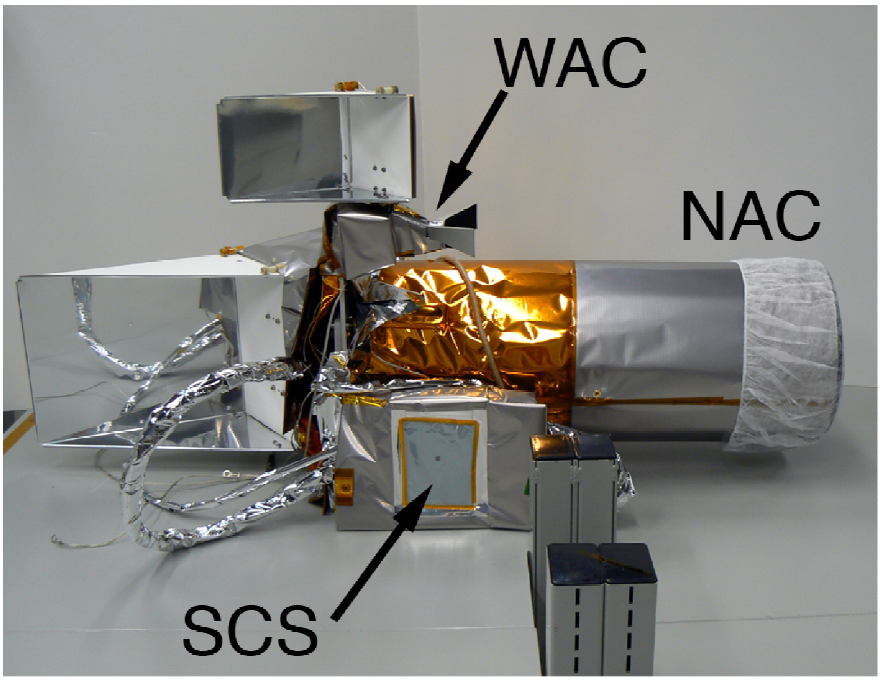

Figure 2.4 - LROC components include the WAC, NAC, and Sequence and Compressor System (SCS).

2.2. Data Product Overview

LROC EDR data products are comprised of the following files:

a. NAC panchromatic image corresponding to a single observation (either un-summed or summed), with Digital Numbers (DN) counts in a 12-bit to 8-bit companded format. The NAC EDR file size will be a maximum of 256MB for the un-summed 50000 lines or summed 100,000 lines. NAC EDR file sizes will be smaller when fewer lines are acquired.

b. WAC image corresponding to a series of framelet images, with DN counts in a 12-bit to 8-bit companded format. Each framelet is in row-major order. The WAC EDR file size will not exceed 256MB, which corresponds to observing 18.5º of latitude in multi-spectral mode. The WAC exposure and/or inter-frame gap parameters will be modified approximately every 10º of latitude, resulting in an average file size of 139MB. It is important to note that the WAC EDR stores multi-spectral framelets in single band, not as seperate bands with the EDR file.

LROC CDR data products are comprised of the following files:

a. NAC panchromatic image corresponding to a single observation (either un-summed or summed), with un-companded DNs, radiometrically calibrated to radiance or I/F. The NAC CDR file size will be a maximum of 512MB for the decompanded, un-summed 50000 lines or decompanded, summed 100,000 lines. NAC CDR file sizes will be smaller when fewer lines are acquired.

b. WAC image corresponding to a series of framelet images, with un-companded DNs, radiometrically calibrated to radiance or I/F. The WAC CDR file size will not exceed a maximum of 512MB, which corresponds to observing 18.5º of latitude in multi-spectral

mode. The WAC exposure and/or inter-frame gap parameters will be modified approximately every 10º of latitude, resulting in an average file size of 278MB. It is important to note that the WAC EDR stores multi-spectral framelets in single band, not as seperate bands the the CDR file. The WAC CDR file will require further processing to separate framelets into their respective bands and to align the bands, in order to be viewed as standard mutli-band image.

2.3. Data Processing

Post acquisition data processing for WAC and NAC images begins upon delivery of the images to SOC from the MOC. The SOC is designed to handle 300Gbits per day of data downlink, not including ancillary products generated by the MOC. Owing to the large volume of data, the SOC has been designed with a high degree of automation in all aspects of the data processing.

Data is pushed to the SOC using the SSH protocol, with delivery status being checked using MD5 checksums for each file. Failed transfers will be automatically re-initiated by the MOC. Stored housekeeping (spacecraft and LROC instrument), predict and definitive SPICE kernels, command load reports are also delivered to the SOC, some of which are used during data processing. Upon receipt by the SOC, all files are handled by automated processing routines being run within the Conductor framework, to allow for scaleable growth as processing needs grow and recede. At each stage of the automated processing, quality assurance tests are performed, either before processing or after processing occurs, to insure valid products are flowing down-stream through the pipelines. Meta-data about each EDR and CDR file that is processed will be recorded into a PostgreSQL database, which is then be used for the generation of each archive delivery. Archive deliveries are pushed from our production storage array onto a data node storage array, where the data is accessible (in read-only mode) by the LROC PDS data node (http://lroc.sese.asu.edu).

NAC and WAC data should not experience issues with missing data under nominal downlink conditions, owing to the use of the CCSDS File Delivery Protocol (CFDP). Should downlink conditions be degraded such that PDU data packets are missed/lost, the MOC will identify missing PDU data packets, record the start and end bytes values in the Meta-file, and fill the missing bytes with zero values. This will allow the SOC to reconstruct the majority of observations with missing data.

2.3.1. Data Processing Level

The EDR product contains individual NAC and WAC framelet images, and associated engineering data, corresponding to NASA processing Level 0 (CODMAC Level 2).

The CDR product contains individual NAC and WAC framelet images, and associated engineering data, corresponding to NASA processing Level 1a (CODMAC Level 4).

2.3.2. Data Product Generation

The data processing pipeline, executed within the LROC SOC, ingests image files and engineering data, and then combines them with meta-data contained in a relational database, to generate products described by this SIS. LROC image data are companded from 12bit to 8bit, and then losslessly compressed before being written to the spacecraft data recorder.

The processing pipeline can be run multiple iterations to account for discovered software bugs that affect the output data, updates to SPICE information, or if the calibration of the instruments is updated or modified. In either case it is expected the data will be reprocessed by revised software and made available.

All LRO data will be transmitted from the LRO Orbiter to the MOC. The MOC and Flight Dynamics Facility will generate LRO SPICE data files for distribution to the SOCs. LROC image files, as delivered from the MOC, are coupled with engineering data and other previously recorded information in the LROC operations database, to create an EDR product. Valid EDR files are then used as input to the process that performs additional processing to generate CDR files.

NAC science files consist of 8-bit companded pixels as read out from the camera. The image is all of the even pixels from each line (with a 20-byte CTX-heritage header every 1M=1024*1024 bytes) and padded to a 1M boundary, followed by the odd pixels in the same style. The EDR file generation process extracts the odd and even pixels, interleaving them to reconstruct original scan lines. If compression was enabled at image acquisition, the data stream is first de-compressed before the interleaving is performed. Information from the meta-file, housekeeping, and the SOC database are combined to generate the PDS label that combined with the binary data to product the EDR file.

The NAC EDR file is then read in so that the data steam can be uncompanded from 8bit to 16bit. A radiometric calibration is performed on uncompanded DN values, and the resulting data stream is then written out as a PDS compliant CDR file.

WAC science files consist of frames in row-major order with a 4-byte validity marker separating each frame. If compression was enabled at image acquisition, the data stream is first de-compressed before further processing is performed. Information from the meta-file, housekeeping, and the SOC database are combined to generate the PDS label that combined with the binary data to product the EDR file.

The WAC EDR file is then read in so that the data steam can be uncompanded from 8bit to 16bit. A radiometric calibration is performed on uncompanded DN values, and the resulting data stream is then written out as a PDS compliant CDR file.

2.3.3. Data Flow

LROC NAC observations are stored in individual files that correspond to one of the two NAC detectors. Each file is uniquely named to distinguish between the two NACs (see Section 2.3.4). LROC WAC observations are stored as a series of framelets, with each framelet corresponding to

one or more of the seven available bands on the detector. LROC observation and housekeeping files are down-linked through the Ka band antenna at Whites Sands, N.M., then sent to LRO MOC at Goddard Space Flight Center (GSFC), while real-time telemetry is down-linked via S-band antenna at various locations then transferred to the MOC which then sends the stream to the LROC SOC. Once observation and housekeeping files are processed by the MOC, including identification of any missing data segments, the observation files and housekeeping files are transferred to the LROC SOC at ASU via Secure Shell (SSH) file copy protocol. Real-time telemetry is streamed to the LROC SOC as it is received at the MOC (with no processing).

The MOC also sends to the LROC SOC numerous products generated by the GSFC Flight Dynamics group, including predictive and definitive NAIF SPICE kernels. Once all necessary files are received, observations can be ingested into product generation pipelines to produce EDR and CDR PDS products. The pipeline process includes validation of the EDR and CDR products compliance with PDS label and format standards.

At intervals specified in the LROC Data and Management Archive document [*Applicable Documents* 2], EDR and CDR products will be delivered to the PDS, which is the LROC Data Node (http://lroc.sese.asu.edu) hosted at ASU.

2.3.4. Labeling and Identification

LROC EDR and CDR products are identified by a unique name and each file has a header that records salient information regarding each product. Data product names follow the convention as defined in the LROC EDR Archive Volume SIS [*Applicable Documents* 3].

The product header (as described in section 3.2) contains information regarding the processing and generation of the product, including a version number for the product. Should products be reprocessed, the version number in the header section will be updated to reflect the new product.

2.4. Standards Used in Generating Data Products

2.4.1. PDS Standards

The LROC EDR data product complies with Planetary Data System standards for file formats and labels, as specified in the PDS Standards Reference [*Applicable Documents* 5].

2.4.2. Time Standards

LROC EDR and CDR products comply with Planetary Data Systems standards for time, as well as complying with the LRO project agreement on time stamping of data. This includes UTC and S-clock recorded observation times in EDR and CDR product labels.

The LRO spacecraft clock (SCLK) time stamp consists of two fields: SSSSSSSSSS:FFFFF. The SSSSSSSSSS field represents the count of on-board seconds and the FFFFF field represents the count of fractions of a second with one fraction being 1/65536 of a second. Converting between SCLK and other time formats is performed using the MOC provided LRO SCLK kernel and NAIF SPICE toolkit.

2.4.3. Data Storage Conventions

All binary files are arranged with fixed-length records, stored in most-significant-byte-first (big-endian) format. In text files each record is terminated with a carriage return (ASCII code 13) followed by a line feed (ASCII code 10).

2.5. Data Validation

All LROC EDR and CDR products will be validated by the LROC SOC Team and the PDS Imaging Node for compliance with PDS archive standards [*Applicable Documents* 5].

3. Detailed Data Product Specifications

3.1. Data Product Structure and Organization

LROC data products are organized according to the directory structure defined in the LROC EDR Archive Volume SIS [*Applicable Documents* 3]. Data product names follow the convention defined in the LROC EDR Archive Volume SIS [*Applicable Documents* 3].

3.2. Data Format Descriptions

Final label content and format will be validated by PDS Engineering and Imaging Nodes. Resulting changes should of course be reflected within all label descriptions.

3.2.1. Example label for LROC NAC EDR product:

```
PDS_VERSION_ID                = PDS3

/* FILE CHARACTERISTICS */
RECORD_TYPE                   = FIXED_LENGTH
RECORD_BYTES                  = nn
FILE_RECORDS                  = nn
LABEL_RECORDS                 = nn
^IMAGE                        = nn

/* DATA IDENTIFICATION */
DATA_SET_ID                   = "LRO-L-LROC-2-EDR-V1.0"
ORIGINAL_PRODUCT_ID           = "0x76a"
PRODUCT_ID                    = "M010368000LE"
MISSION_NAME                  = "LUNAR RECONNAISSANCE ORBITER"
MISSION_PHASE_NAME            = "COMMISSIONING"
INSTRUMENT_HOST_NAME          = "LUNAR RECONNAISSANCE ORBITER"
INSTRUMENT_HOST_ID            = LRO
INSTRUMENT_NAME               = "LUNAR RECONNAISSANCE ORBITER CAMERA"
INSTRUMENT_ID                 = “LROC”
START_TIME                    = CCYY-MM-DDThh:mm:ss.sss
STOP_TIME                     = CCYY-MM-DDThh:mm:ss.sss
SPACECRAFT_CLOCK_START_COUNT  = sclk string
SPACECRAFT_CLOCK_STOP_COUNT   = “N/A”
```

```
ORBIT_NUMBER                  = nnnnn
PRODUCER_ID                   = "LRO_LROC_TEAM"
PRODUCT_CREATION_TIME         = CCYY-MM-DDThh:mm:ss.sss
PRODUCER_INSTITUTION_NAME     = "ARIZONA STATE UNIVERSITY"
PRODUCT_TYPE                  = EDR
PRODUCT_VERSION_ID            = "V001"
UPLOAD_ID                     = "command file id"

/* DATA DESCRIPTION */
CROSSTRACK_SUMMING            = 1
RATIONALE_DESC                = List of keywords captured in REACT or the
                                string "TARGET OF OPPORTUNITY"
DATA_QUALITY_ID               = 00000000
TARGET_NAME                   = "MOON"
FRAME_ID                      = ”LEFT”
LRO:TEMPERATURE_SCS_RAW       =
LRO:TEMPERATURE_SCS           = <degC>
LRO:TEMPERATURE_FPA_RAW       =
LRO:TEMPERATURE_FPA           = <degC>
LRO:TEMPERATURE_FPGA_RAW      =
LRO:TEMPERATURE_FPGA          = <degC>
LRO:TEMPERATURE_TELESCOPE_RAW =
LRO:TEMPERATURE_TELESCOPE     = <degC>
LINE_EXPOSURE_DURATION        = fffff.f
LRO:LOOKUP_TABLE_TYPE         = "STORED"
LRO:LOOKUP_CONVERSION_TABLE   = <replace with companding table used>

/* DATA OBJECT */
OBJECT                        = IMAGE
  LINES                       = 0
  LINE_SAMPLES                = 0
  SAMPLE_BITS                 = 8
  SAMPLE_TYPE                 = LSB_INTEGER
  MD5_CHECKSUM                = "CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC"
END_OBJECT

END
```

3.2.2. Example label for LROC NAC CDR product:

```
PDS_VERSION_ID                = PDS3

/* FILE CHARACTERISTICS */
RECORD_TYPE                   = FIXED_LENGTH
RECORD_BYTES                  = nn
FILE_RECORDS                  = nn
LABEL_RECORDS                 = nn
^IMAGE                        = nn

/* DATA IDENTIFICATION */
DATA_SET_ID                   = "LRO-L-LROC-3-CDR-V1.0"
ORIGINAL_PRODUCT_ID           = "0x76a"
PRODUCT_ID                    = "M010368000RC"
MISSION_NAME                  = "LUNAR RECONNAISSANCE ORBITER"
MISSION_PHASE_NAME            = "COMMISSIONING"
INSTUMENT_HOST_NAME           = "LUNAR RECONNAISSANCE ORBITER"
INSTRUMENT_HOST_ID            = LRO
INSTRUMENT_NAME               = "LUNAR RECONNAISSANCE ORBITER CAMERA"
INSTRUMENT_ID                 = ”LROC”
START_TIME                    = CCYY-MM-DDThh:mm:ss.sss
STOP_TIME                     = CCYY-MM-DDThh:mm:ss.sss
SPACECRAFT_CLOCK_START_COUNT  = sclk string
```

```
SPACECRAFT_CLOCK_STOP_COUNT   = “N/A”
ORBIT_NUMBER                  = nnnnn
PRODUCER_ID                   = "LRO_LROC_TEAM"
PRODUCT_CREATION_TIME         = CCYY-MM-DDThh:mm:ss.sss
PRODUCER_INSTITUTION_NAME     = "ARIZONA STATE UNIVERSITY"
PRODUCT_TYPE                  = EDR
PRODUCT_VERSION_ID            = "V001"
UPLOAD_ID                     = "command file id"

/* DATA DESCRIPTION */
CROSSTRACK_SUMMING            = 1
RATIONALE_DESC                = List of keywords captured in REACT or the
                                string "TARGET OF OPPORTUNITY"
DATA_QUALITY_ID               = 00000000
TARGET_NAME                   = "MOON"
FRAME_ID                      = “RIGHT”
LRO:TEMPERATURE_SCS_RAW       = nnnn
LRO:TEMPERATURE_SCS           = <degC>
LRO:TEMPERATURE_FPA_RAW       = nnnn
LRO:TEMPERATURE_FPA           = <degC>
LRO:TEMPERATURE_FPGA_RAW      = nnnn
LRO:TEMPERATURE_FPGA          = <degC>
LRO:TEMPERATURE_TELESCOPE_RAW = nnnn
LRO:TEMPERATURE_TELESCOPE     = <degC>
LINE_EXPOSURE_DURATION        = fffff.f
LRO:LOOKUP_TABLE_TYPE         = "STORED"
LRO:LOOKUP_CONVERSION_TABLE   = <replace with companding table used>

/* DATA OBJECT */
OBJECT                        = IMAGE
  LINES                       = 0
  LINE_SAMPLES                = 0
  SAMPLE_BITS                 = 16
  SAMPLE_TYPE                 = LSB_INTEGER
  MD5_CHECKSUM                = "CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC"
END_OBJECT

END
```

3.2.3. Example label for LROC WAC EDR product:

```
PDS_VERSION_ID                = PDS3

/* FILE CHARACTERISTICS */
RECORD_TYPE                   = FIXED_LENGTH
RECORD_BYTES                  = nn
FILE_RECORDS                  = nn
LABEL_RECORDS                 = nn
^IMAGE                        = nn

/* DATA IDENTIFICATION */
DATA_SET_ID                   = "LRO-L-LROC-2-EDR-V1.0"
ORIGINAL_PRODUCT_ID           = "0x66a"
PRODUCT_ID                    = "M010368000CE"
MISSION_NAME                  = "LUNAR RECONNAISSANCE ORBITER"
MISSION_PHASE_NAME            = "COMMISSIONING"
INSTRUMENT_HOST_NAME          = "LUNAR RECONNAISSANCE ORBITER"
INSTRUMENT_HOST_ID            = LRO
INSTRUMENT_NAME               = "LUNAR RECONNAISSANCE ORBITER CAMERA"
INSTRUMENT_ID                 = “LROC”
START_TIME                    = CCYY-MM-DDThh:mm:ss.sss
```

```
STOP_TIME                       = CCYY-MM-DDThh:mm:ss.sss
SPACECRAFT_CLOCK_START_COUNT    = sclk string
SPACECRAFT_CLOCK_STOP_COUNT     = “N/A”
ORBIT_NUMBER                    = nnnnn
PRODUCT_CREATION_TIME           = CCYY-MM-DDThh:mm:ss.sss
PRODUCER_ID                     = "LRO_LROC_TEAM"
PRODUCER_INSTITUTION_NAME       = "ARIZONA STATE UNIVERSITY"
PRODUCT_TYPE                    = EDR
PRODUCT_VERSION_ID              = "V001"
UPLOAD_ID                       = "command file id"

/* DATA DESCRIPTION */
RATIONALE_DESC                  = "TEST IMAGE, N/A RATIONALE"
DATA_QUALITY_ID                 = 00000000
TARGET_NAME                     = "MOON"
LRO:BEGIN_TEMPERATURE_SCS_RAW       = nnnn
LRO:BEGIN_TEMPERATURE_SCS           = <degC>
LRO:BEGIN_TEMPERATURE_FPA_RAW       = nnnn
LRO:BEGIN_TEMPERATURE_FPA           = <degC>
LRO:MIDDLE_TEMPERATURE_SCS_RAW      = nnnn
LRO:MIDDLE_TEMPERATURE_SCS          = <degC>
LRO:MIDDLE_TEMPERATURE_FPA_RAW      = nnnn
LRO:MIDDLE_TEMPERATURE_FPA          = <degC>
LRO:END_TEMPERATURE_SCS_RAW         = nnnn
LRO:END_TEMPERATURE_SCS             = <degC>
LRO:END_TEMPERATURE_FPA_RAW         = nnnn
LRO:END_TEMPERATURE_FPA             = <degC>
LINE_EXPOSURE_DURATION          = f.ffff
INTERFRAME_DELAY                = f.ffffff
INSTRUMENT_MODE_ID              = "BW" or "COLOR" or "UV" or "VIS"
FILTER_NUMBER                   = (4) or (5) (1,2,3,4,5,6,7) or (1,2) or
                                  (3,4,5,6,7)
FILTER_NAME                     = (560) or (600) or (315, 360, 415, 560, 600,
                                  640, 680) or (315, 360) or (415, 560, 600,
                                  640, 680)
LRO:LOOKUP_TABLE_TYPE           = "STORED"
LRO:LOOKUP_CONVERSION_TABLE     = <replace with companding table used>

/* DATA OBJECT */
OBJECT                          = IMAGE
  LINES                         = 0
  LINE_SAMPLES                  = 0
  SAMPLE_BITS                   = 8
  SAMPLE_TYPE                   = LSB_INTEGER
  MD5_CHECKSUM                  = "CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC"
END_OBJECT

END
```

3.2.4. Example label for LROC WAC CDR product:

```
PDS_VERSION_ID                  = PDS3

/* FILE CHARACTERISTICS */
RECORD_TYPE                     = FIXED_LENGTH
RECORD_BYTES                    = nn
FILE_RECORDS                    = nn
LABEL_RECORDS                   = nn
^IMAGE                          = nn

/* DATA IDENTIFICATION */
```

```
DATA_SET_ID                    = "LRO-L-LROC-3-CDR-V1.0"
ORIGINAL_PRODUCT_ID            = "0x66a"
PRODUCT_ID                     = "M010368000MC"
MISSION_NAME                   = "LUNAR RECONNAISSANCE ORBITER"
MISSION_PHASE_NAME             = "COMMISSIONING"
INSTRUMENT_HOST_NAME           = "LUNAR RECONNAISSANCE ORBITER"
INSTRUMENT_HOST_ID             = LRO
INSTRUMENT_NAME                = "LUNAR RECONNAISSANCE ORBITER CAMERA"
INSTRUMENT_ID                  = “LROC”
START_TIME                     = CCYY-MM-DDThh:mm:ss.sss
STOP_TIME                      = CCYY-MM-DDThh:mm:ss.sss
SPACECRAFT_CLOCK_START_COUNT   = sclk string
SPACECRAFT_CLOCK_STOP_COUNT    = “N/A”
ORBIT_NUMBER                   = nnnnn
PRODUCT_CREATION_TIME          = CCYY-MM-DDThh:mm:ss.sss
PRODUCER_ID                    = "LRO_LROC_TEAM"
PRODUCER_INSTITUTION_NAME      = "ARIZONA STATE UNIVERSITY"
PRODUCT_TYPE                   = CDR
PRODUCT_VERSION_ID             = "V001"
UPLOAD_ID                      = "command file id"

/* DATA DESCRIPTION */
RATIONALE_DESC                 = "TEST IMAGE, N/A RATIONALE"
DATA_QUALITY_ID                = 00000000
TARGET_NAME                    = "MOON"
LRO:BEGIN_TEMPERATURE_SCS_RAW       = nnnn
LRO:BEGIN_TEMPERATURE_SCS           = <degC>
LRO:BEGIN_TEMPERATURE_FPA_RAW       = nnnn
LRO:BEGIN_TEMPERATURE_FPA           = <degC>
LRO:MIDDLE_TEMPERATURE_SCS_RAW      = nnnn
LRO:MIDDLE_TEMPERATURE_SCS          = <degC>
LRO:MIDDLE_TEMPERATURE_FPA_RAW      = nnnn
LRO:MIDDLE_TEMPERATURE_FPA          = <degC>
LRO:END_TEMPERATURE_SCS_RAW         = nnnn
LRO:END_TEMPERATURE_SCS             = <degC>
LRO:END_TEMPERATURE_FPA_RAW         = nnnn
LRO:END_TEMPERATURE_FPA             = <degC>
LINE_EXPOSURE_DURATION         = f.ffff
INTERFRAME_DELAY               = f.ffffff
INSTRUMENT_MODE_ID             = "BW" or "COLOR" or "UV" or "VIS"
FILTER_NUMBER                  = (4) or (5) (1,2,3,4,5,6,7) or (1,2) or
                                 (3,4,5,6,7)
FILTER_NAME                    = (560) or (600) or (315, 360, 415, 560, 600,
                                 640, 680) or (315, 360) or (415, 560, 600,
                                 640, 680)
LRO:LOOKUP_TABLE_TYPE          = "STORED"
LRO:LOOKUP_CONVERSION_TABLE    = <replace with companding table used>

/* DATA OBJECT */
OBJECT                         = IMAGE
  LINES                        = 0
  LINE_SAMPLES                 = 0
  SAMPLE_BITS                  = 16
  SAMPLE_TYPE                  = LSB_INTEGER
  MD5_CHECKSUM                 = "CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC"
END_OBJECT

END
```

3.3. Label and Header Descriptions

PDS_VERSION_ID

The PDS version number for the header format; always PDS3.

RECORD_TYPE

The record type for this file; always FIXED_LENGTH.

RECORD_BYTES

The number of bytes per record.

FILE_RECORDS

The total number of records in this file.

LABEL_RECORDS

The total number of records used for the header data.

^IMAGE

A pointer to the starting record of the image object.

DATA_SET_ID

For EDR products, set to LRO-L-LROC-2-EDR-V1.0. For CDR products, set to LRO-L-LROC-3-CDR-V1.0.

ORIGINAL_PRODUCT_ID

Product ID of this image as received from the LRO MOC. Example LROC_YYYYDDD_TTTTHHHHHHHH.sci, where YYYY is the year, DDD is the day of year, TTTT is the LROC instrument (NAC_L, NAC_R, WAC) and HHHHHHHH is the hex encoded Image ID.

PRODUCT_ID

Unique identifier for this LROC NAC and WAC EDR/CDR product. Example [TARGET][MET][INSTRUMENT][PRODUCT] where [TARGET] is a single character denoting the observation target [(M)oon, (E)arth, (C)alibration or (S)tar, [MET] is a nine digit number reflecting the MET of acquisition (with a single digit for partition), [INSTRUMENT] is a single character denoting the instrument [(R)ight NAC, (L)eft NAC, (M)onochrome WAC, or (C)olor WAC, and [PRODUCT] is a single character denoting an (E)DR product or (C)DR product.

MISSION_NAME

Always "LUNAR RECONNAISSANCE ORBITER".

MISSION_PHASE_NAME

Name of the mission phase; "COMMISSIONING", “NOMINAL MISSION” or “EXTENDED MISSION”.

INSTRUMENT_HOST_NAME

Always "LUNAR RECONNAISSANCE ORBITER".

INSTRUMENT_HOST_ID

Always LRO.

INSTRUMENT_NAME

Always "LUNAR RECONNAISSANCE ORBITER CAMERA".

INSTRUMENT_ID

Always “LROC”.

START_TIME

The UTC time and date at the start of the image acquisition.

STOP_TIME

The UTC time and date at the end of the image acquisition.

SPACECRAFT_CLOCK_START_COUNT

Set to the sclk string for the start of an observation.

SPACECRAFT_CLOCK_STOP_COUNT

Not applicable to NAC or WAC observation timing.

ORBIT_NUMBER

Set to the LRO orbit revolution on which this image was acquired.

PRODUCT_CREATION_TIME

Set to time and date for the creation of this PDS product file, in the form of CCYY-MM-DDThh:mm:ss.sss.

PRODUCER_ID

Always set to "LRO_LROC_TEAM".

PRODUCER_INSTITUTION_NAME

Always set to "ARIZONA STATE UNIVERSITY".

PRODUCT_TYPE

What kind of PDS product this file represents. Can be either EDR or CDR.

PRODUCT_VERSION_ID

The product version, starting at V001 and incremented for each version released.

UPLOAD_ID

The identifier for the command load used to acquire this image.

CROSSTRACK_SUMMING

Indicates if NAC observation was taken with crosstrack summing (2) or no crosstrack summing (1). Keyword only applies to NAC products.

RATIONALE_DESC

For NAC observations, set to one of the following: the keywords recorded in the REACT ROI, the appropriate NAC campaign, or set to the string TARGET OF OPPORTUNITY. For WAC observations, set to either the appropriate campaign or GLOBAL_COVERAGE.

DATA_QUALITY_ID

Set to an 8-bit value which encodes data quality information for the observation. The 8-bit value is interpreted as:

Bit 1: Records if temperature is out of bounds for focal plane array.

0 = nominal temperature

1 = out-of-bounds

Bit 2: Records if threshold for saturated pixels is reached (> 0.1% of total pixels).

0 = saturated pixel count is below 0.1% threshold

1 = saturated pixel count is equal to or greater than 0.1% threshold

Bit 3: Records if threshold for under-saturated pixels is reached (> 0.1% of total pixels).

0 = under-saturated pixel count is below 0.1% threshold

1 = under-saturated pixel counts is equal to or greater than 0.1% threshold

Bit 4: Records if observation is missing telemetry packets.

0 = no missing telemetry packets

1 = missing telemetry packets

Bit 5: Records if SPICE information is bad or missing for observation acquisition time.

0 = no bad or missing SPICE information for observation

1 = bad or missing SPICE information for observation

Bit 6: Records if observation or spacecraft housekeeping information is bad or missing for observation acquisition time.

0 = no bad or missing observation or spacecraft housekeeping information

1= bad or missing observation or spacecraft housekeeping information

Bit 7: Spare

Bit 8: Spare

TARGET_NAME

Set to the target body: MOON for any nominal lunar imaging, EARTH for any observations of the Earth, CAL for any non-STAR calibration images, and STAR for star calibration images.

LRO:TEMPERATURE_SCS_RAW

Set to the raw engineering counts for the LROC SCS.

LRO:TEMPERATURE_SCS

Set to the temperature of the LROC SCS in degrees C, as converted from the raw engineering counts.

LRO:TEMPERATURE_FPA_RAW

Set to the raw engineering counts for the LROC (F)ocal (P)lane (A)rray.

LRO:TEMPERATURE_FPA

Set to the temperature of the LROC FPA in degrees C, as converted from the raw engineering counts.

LRO:BEGIN_TEMPERATURE_SCS_RAW

Set to the raw engineering counts for the LROC SCS at the beginning of a series of WAC frames.

LRO:BEGIN_TEMPERATURE_SCS

Set to the temperature of the LROC SCS in degrees C, as converted from the raw engineering counts, at the beginning of a series of WAC frames.

LRO:BEGIN_TEMPERATURE_FPA_RAW

Set to the raw engineering counts for the LROC (F)ocal (P)lane (A)rray at the beginning of a series of WAC frames.

LRO:BEGIN_TEMPERATURE_FPA

Set to the temperature of the LROC FPA in degrees C, as converted from the raw engineering counts, at the beginning of a series of WAC frames.

LRO:MIDDLE_TEMPERATURE_SCS_RAW

Set to the raw engineering counts for the LROC SCS at the middle of a series of WAC frames.

LRO:MIDDLE_TEMPERATURE_SCS

Set to the temperature of the LROC SCS in degrees C, as converted from the raw engineering counts, at the middle of a series of WAC frames.

LRO:MIDDLE_TEMPERATURE_FPA_RAW

Set to the raw engineering counts for the LROC (F)ocal (P)lane (A)rray at the middle of a series of WAC frames.

LRO:MIDDLE_TEMPERATURE_FPA

Set to the temperature of the LROC FPA in degrees C, as converted from the raw engineering counts, at the middle of a series of WAC frames.

LRO:END_TEMPERATURE_SCS_RAW

Set to the raw engineering counts for the LROC SCS at the end of a series of WAC frames.

LRO:END_TEMPERATURE_SCS

Set to the temperature of the LROC SCS in degrees C, as converted from the raw engineering counts, at the end of a series of WAC frames.

LRO:END_TEMPERATURE_FPA_RAW

Set to the raw engineering counts for the LROC (F)ocal (P)lane (A)rray at the end of a series of WAC frames.

LRO:END_TEMPERATURE_FPA

Set to the temperature of the LROC FPA in degrees C, as converted from the raw engineering counts, at the end of a series of WAC frames.

LRO:TEMPERATURE_FPGA_RAW

Set to the raw engineering counts for the LROC (F)ield (P)rogrammable (G)ate (A)rray.

LRO:TEMPERATURE_FPGA

Set to the temperature of the LROC FPGA in degrees C, as converted from the raw engineering counts.

LRO:TEMPERATURE_TELESCOPE_RAW

Set to the raw engineering counts for the LROC Telescope corresponding to NAC-L or NAC-R.

LRO:TEMPERATURE_TELESCOPE

Set to the temperature of the LROC telescope corresponding to NAC-L or NAC-R, as converted from the raw engineering counts.

LINE_EXPOSURE_DURATION

For NAC products, LINE_EXPOSURE_DURATION can have values between 337.6 and 35,281.6 microseconds, in 128/15 microsecond increments.

For WAC products, LINE_EXPOSURE_DURATION can have values between 0 and 6.5535 seconds, in 100 microsecond incremenets.

INTERFRAME_DELAY

Set to the value of the interframe delay between WAC framelets. Keyword can have values between 25/64 and 280/64 seconds, in 1/64 seconds increments.

FRAME_ID

For NAC, records if the image was acquired from the “LEFT” or “RIGHT” NAC.

INSTRUMENT_MODE_ID

Records the commanded WAC mode: BW, COLOR, VIS or UV.

FILTER_NUMBER

Records the WAC filter numbers taken during an observation, which corresponds to the INSTRUMENT_MODE_ID: (4) or (5) or (1,2,3,4,5,6,7) or (1,2,3,4,5) or (6,7). Filter (4) is optimal BW band, with filter (5) as an alternate.

FILTER_NAME

Records the WAC filter names taken during an observation, which corresponds to the FILTER_NUMBER: (560) or (600) or (315,360,415,560,600,640,680) or (315,360,415,560,600) or (640,680).

LRO:LOOKUP_TABLE_TYPE

Always set to STORED.

LRO:LOOKUP_CONVERSION_TABLE

The table defines the translation from 8-bit back to 12-bit pixels. There are 256 pairs of values in the table. The first pair in the table corresponds to the range of 12-bit pixels that map to 0 DN value of the output 8-bit pixel. Subsequent pairs correspond to incremental output DN values.

Table is included in CDR products for completeness, de-companding has already occurred during the generation of the CDR. Example:

LRO:LOOKUP_CONVERSION_TABLE= ((0,100), (101,200), (201,300),...)

Input pixel values 0-100 were mapped to output DN value 0, 101-200 mapped to DN value 1, 201-300 mapped to DN 2, etc.)

MD5_CHECKSUM

The calculated MD5 checksum for the object data stream, as a 32 character string value.

LINES

Set to the number of lines captured by the observation.

LINE_SAMPLES

Set to the number of samples in a line.

SAMPLE_BITS

Set to 8-bit for EDR products and set to 16-bit for CDR products.

SAMPLE_TYPE

Always set to LSB_INTEGER.

Appendix A – Glossary

Archive – An archive consists of one or more data sets along with all the documentation and ancillary information needed to understand and use the data. An archive is a logical construct independent of the medium on which it is stored.

Archive Volume, Archive Volume Set – A volume is a unit of media on which data products are stored; for example, one CD-ROM or DVD-ROM. An *archive volume* is a volume containing all or part of an archive; that is, data products plus documentation and ancillary files. When an archive spans multiple volumes, they are called an *archive volume set*. Usually the documentation and some ancillary files are repeated on each volume of the set, so that a single volume can be used alone. The LROC EDR Archive will be stored, distributed, and archived solely on computer disk for the foreseeable future (there will be no formal hard-copy archive such as CD-ROM or DVD-ROM).

Catalog Information – Descriptive information about a data set (e.g. mission description, spacecraft description, instrument description), expressed in Object Description Language (ODL) which is suitable for loading into a PDS catalog.

Companding – A method for mitigating the detrimental effects of a channel with limited dynamic range. The use of companding allows signals with a large dynamic range to be transmitted over facilities that have a smaller dynamic range capability.

Data Product – A labeled grouping of data resulting from a scientific observation, usually stored in one file. A product label identifies, describes, and defines the structure of the data. An example of a data product is a planetary image, a spectrum table, or a time series table.

Data Set – An accumulation of data products. A data set together with supporting documentation and ancillary files is an archive.

I/F – Defined as the spectral radiance divided by the solar spectral irradiance of the Sun at target distance divided by pi. Thus, it is the ratio of the radiance observed from a surface to that of a perfect white Lambertian surface illuminated by the same light but at normal incidence.

MD5 – The Message Digest algorithm 5 is widely used cryptographic hash function with a 128-bit hash value, commonly used to check the integrity of files. An MD5 hash is typically expressed as a 32-character string of hexadecimal numbers..

Standard Data Product – A data product generated in a predefined way using well-understood procedures, processed in "pipeline" fashion. Data products that are generated in a nonstandard way are sometimes called *special data products*.

Appendix B – NAC and WAC Lookup Table

NAC square-root companding table:

8-bit	12-bit
0	0
1	2
2	4
3	6
4	8
5	10
6	12
7	14
8	16
9	18
10	20
11	22
12	24
13	26
14	28
15	30
16	32
17	36
18	40
19	44
20	48
21	52
22	56
23	60
24	64
25	68
26	72
27	76
28	80
29	84
30	88
31	92
32	96
33	100
34	104
35	108
36	112
37	116
38	120
39	124
40	128

41	132
42	136
43	144
44	152
45	160
46	168
47	176
48	184
49	192
50	200
51	208
52	216
53	224
54	232
55	240
56	248
57	256
58	264
59	272
60	280
61	288
62	296
63	304
64	312
65	320
66	328
67	336
68	344
69	352
70	360
71	368
72	376
73	384
74	392
75	400
76	408
77	416
78	424
79	432
80	440
81	448
82	456
83	464
84	472
85	480
86	488

87	496
88	504
89	512
90	520
91	528
92	536
93	552
94	568
95	584
96	600
97	616
98	632
99	648
100	664
101	680
102	696
103	712
104	728
105	744
106	760
107	776
108	792
109	808
110	824
111	840
112	856
113	872
114	888
115	904
116	920
117	936
118	952
119	968
120	984
121	1000
122	1016
123	1032
124	1048
125	1064
126	1080
127	1096
128	1112
129	1128
130	1144
131	1160
132	1176

133	1192
134	1208
135	1224
136	1240
137	1256
138	1272
139	1288
140	1304
141	1320
142	1336
143	1352
144	1368
145	1384
146	1400
147	1416
148	1432
149	1448
150	1464
151	1480
152	1496
153	1512
154	1528
155	1544
156	1560
157	1576
158	1592
159	1608
160	1624
161	1640
162	1656
163	1672
164	1688
165	1704
166	1720
167	1736
168	1752
169	1768
170	1784
171	1800
172	1816
173	1832
174	1848
175	1864
176	1880
177	1896
178	1912

179	1928
180	1944
181	1960
182	1976
183	1992
184	2008
185	2024
186	2040
187	2056
188	2072
189	2088
190	2104
191	2120
192	2136
193	2152
194	2168
195	2184
196	2200
197	2232
198	2264
199	2296
200	2328
201	2360
202	2392
203	2424
204	2456
205	2488
206	2520
207	2553
208	2585
209	2617
210	2649
211	2681
212	2713
213	2746
214	2778
215	2810
216	2842
217	2874
218	2906
219	2938
220	2970
221	3002
222	3035
223	3067
224	3099

225	3131
226	3163
227	3195
228	3227
229	3259
230	3292
231	3324
232	3356
233	3388
234	3420
235	3452
236	3484
237	3516
238	3548
239	3581
240	3613
241	3645
242	3677
243	3709
244	3741
245	3773
246	3805
247	3838
248	3870
249	3902
250	3934
251	3966
252	3998
253	4030
254	4062
255	4095

WAC square-root companding table:

8-bit	11-bit
0	0
1	3
2	6
3	9
4	12
5	15
6	18
7	21
8	24
9	27

10	30
11	33
12	36
13	39
14	42
15	45
16	48
17	51
18	54
19	57
20	60
21	63
22	66
23	69
24	72
25	75
26	78
27	81
28	84
29	87
30	90
31	93
32	96
33	99
34	102
35	105
36	108
37	111
38	114
39	117
40	120
41	127
42	132
43	138
44	143
45	149
46	154
47	160
48	165
49	171
50	176
51	182
52	187
53	193
54	198
55	204

56	209
57	215
58	220
59	226
60	231
61	237
62	242
63	248
64	253
65	259
66	264
67	270
68	275
69	281
70	286
71	292
72	297
73	303
74	308
75	314
76	319
77	325
78	330
79	336
80	341
81	347
82	352
83	358
84	363
85	369
86	374
87	380
88	385
89	391
90	396
91	402
92	407
93	413
94	418
95	424
96	429
97	435
98	440
99	446
100	451
101	457

102	462
103	468
104	474
105	481
106	489
107	497
108	505
109	513
110	520
111	528
112	536
113	544
114	552
115	559
116	567
117	575
118	583
119	591
120	598
121	606
122	614
123	622
124	630
125	637
126	645
127	653
128	661
129	669
130	676
131	684
132	692
133	700
134	708
135	715
136	723
137	731
138	739
139	747
140	754
141	762
142	770
143	778
144	786
145	793
146	801
147	809

148	817
149	825
150	832
151	840
152	848
153	856
154	864
155	871
156	879
157	887
158	895
159	903
160	910
161	918
162	926
163	934
164	942
165	949
166	957
167	965
168	973
169	981
170	990
171	1000
172	1011
173	1021
174	1032
175	1042
176	1053
177	1063
178	1074
179	1084
180	1095
181	1105
182	1116
183	1126
184	1137
185	1147
186	1158
187	1168
188	1179
189	1189
190	1200
191	1210
192	1221
193	1231

194	1242
195	1252
196	1263
197	1273
198	1284
199	1294
200	1305
201	1315
202	1326
203	1336
204	1347
205	1357
206	1368
207	1378
208	1389
209	1399
210	1410
211	1420
212	1431
213	1441
214	1452
215	1462
216	1473
217	1483
218	1494
219	1504
220	1515
221	1525
222	1536
223	1546
224	1557
225	1567
226	1578
227	1588
228	1599
229	1609
230	1620
231	1630
232	1641
233	1651
234	1662
235	1672
236	1683
237	1693
238	1704
239	1714

240	1725
241	1735
242	1746
243	1756
244	1767
245	1782
246	1800
247	1817
248	1835
249	1853
250	1870
251	1888
252	1906
253	1924
254	1941
255	2047